California Environmental Protection Agency

# Air Resources Board

STAFF REPORT: INITIAL STATEMENT OF REASONS

**PUBLIC HEARING TO ADOPT CALIFORNIA'S HEAVY-DUTY DIESEL IN-USE COMPLIANCE REGULATION**

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## *EXECUTIVE SUMMARY*

In the 1990s, seven of the largest heavy-duty diesel engine (HDDE) manufacturers (herein referred to as the "settling manufacturers") were alleged to have violated state and federal emission laws by disabling emission control devices on HDDEs during in-use, on highway driving. These cases were resolved through enforcement actions which were concluded when settlement agreements were reached with the settling manufacturers.

In these settlement agreements, the settling manufacturers were required, among other things, to produce HDDEs meeting the 2004 standards earlier, no later than October 1, 2002. It was also determined that the certification test procedure, the Federal Test Procedure, was not comprehensive enough to ensure that exhaust emissions were controlled under all driving conditions. Thus, the majority of these settling manufacturers were also required to produce engines that comply with supplemental test procedures, including the Not-To-Exceed (NTE) requirements and the EURO III European Stationary Cycle (ESC) test. However, the supplemental test procedures, under the Settlement agreement, sunsetted on January 1, 2005.

### *Existing Regulations*

In December 2000, the ARB adopted the NTE and ESC supplemental test procedures as part of the HDDE regulations, applicable to HDDEs produced on or after January 1, 2005. In October 2001, the ARB adopted more stringent emission standards and made minor modifications to the supplemental test procedures for 2007 and subsequent model year HDDEs, aligning the California and federal HDDE emission requirements. The 2007 emission standards represent a 90% reduction of oxides of nitrogen (NOx), 72% reduction of non-methane hydrocarbons (NMHC), and 90% reduction of particulate matter (PM) emissions compared to the 2004 emission standards.

Currently, the California Code of Regulations, title 13, sections 2111-2140, grants ARB the authority to conduct in-use compliance testing of HDDEs to ensure compliance with the applicable emission standards throughout their useful life. According to the existing in-use compliance testing procedures, a minimum of ten engines must be tested on an engine dynamometer. To show compliance, the testing must satisfy two criteria: (a) the engine family must meet the engine certification emission standards based on the average emissions of the ten engines tested, and (b) no more than two defects of the same emission related component can occur. The existing procedures require that trucks be taken out of service, have their engines removed, and then be installed on an engine dynamometer. It is a time consuming and costly process (roughly costing $250,000 per engine family). Primarily for this reason, ARB has not conducted any in-use compliance testing on HDDEs.

### *Proposed Regulation*

The proposed regulation would implement a manufacturer-run in-use compliance program for HDDEs, based on an agreement among ARB, U.S. EPA, and engine manufacturers in May 2003 (ARB, U.S. EPA, EMA, 2003). Specifically, the engine manufacturers would be responsible for screening, procuring and testing heavy-duty diesel vehicles. Portable emission measurement systems (PEMS) would be utilized to conduct over-the-road emission measurement testing of HDDEs. The proposed program would assess NTE compliance of 2007 and newer HDDEs in-use, and would help ensure overall compliance with the 2007 emission standards throughout the engine's useful life. Currently, a non-enforceable pilot program is being conducted to gain experience with in-use NTE testing utilizing PEMS. Starting in 2007, a federal enforcement program for gaseous emissions will begin, followed by an enforcement program for PM in 2008. The federal program is essentially identical to staff's proposal.

The proposed program would apply to all 2007 and subsequent model year engine dynamometer certified diesel engines to be installed in vehicles with gross vehicle weight ratings greater than 8,500 pounds. Each year, ARB and U.S. EPA would designate for testing up to 25% of a manufacturer's total number of medium- and heavy-duty diesel engine families, combined. The proposed test program has two phases. The first phase, Phase 1, would involve testing a designated engine family for conformity with the applicable NTE requirements. If the engine family does not pass the Phase 1 requirements, then Phase 2 testing, under more narrowly defined test conditions, may be required. Emissions that would be measured for compliance are: NOx, NMHC, carbon monoxide (CO), and PM.

### *Compliance Determination*

To show compliance with the proposed requirements, 90 percent of the average emissions of all time-weighted NTE sampling events must be below the NTE threshold for each pollutant. The NTE threshold is comprised of the NTE emission limit, plus a measurement accuracy margin and an in-use compliance margin. In addition, for model years 2007 through 2009, each sampling event must not be greater than 2 times the NTE threshold, regardless of whether the 90 percent pass criteria was met. A valid NTE sampling event consists of 30 seconds or more of continuous operation in the NTE control area.

The engine manufacturer would likely be required to test between 5 and 20 vehicles per engine family, depending on whether Phase 1 only or Phase 1 and Phase 2 testing was completed, and the number of test vehicles that failed to comply. After evaluating all test data, ARB staff would determine whether that engine family meets the emission requirements for that year's testing or whether remedial action is warranted.

### *Reporting Requirements*

The engine manufacturers would report test data and other relevant in-use test information, with a comprehensive report using a standardized, electronic reporting format on a quarterly basis, no later than 30 days after the quarter ends. The report

must include all measured emissions test data, engine operating parameters, test conditions, test equipment specifications, vehicle and engine information.

***Technological Feasibility***

The success of the proposed program would depend on ensuring that the PEMS can correctly measure the exhaust emissions from heavy-duty diesel vehicles in the field. Because testing would be conducted in the field instead of an environmentally controlled laboratory environment, ARB, U.S. EPA and the engine manufacturers have agreed to determine a measurement "accuracy margin" for each pollutant to account for any potential difference in measurement accuracy. The accuracy margins are currently being determined by an independent contractor, Southwest Research Institute.

***Economic Impacts to Business***

The proposed regulation would affect about 13 medium- and heavy-duty engine manufacturers who certify their engines for sale in California and a few PEMS manufacturers. None of the engine manufacturers is located in California, and none is considered to be a small business. One PEMS manufacturer is located in California and is considered a small business. The proposed regulation poses no additional costs to engine manufacturers since the manufacturers are already subjected to an identical rule adopted by U.S. EPA in June 2005. The total per manufacturer cost consists of fixed and variable cost components. When combining the fixed and variable costs together, the average annual cost per manufacturer ranges from $123,884 to $163,927. The actual cost to a specific manufacturer will vary depending on how many engine families it certifies in a year, how many vehicles are tested in Phase 1 for a given engine family, whether Phase 2 testing occurs for a given engine family, and on other variables. The total cost to conduct the proposed program nationwide is estimated to range from $1.6 to $2.1 million per year for the 13 engine manufacturers. The proposed program, implemented on a nationwide basis, would potentially result in the average annual sale of $1.3 million in PEMS units, and thus provide an economic benefit to PEMS manufacturers. The proposed regulation would not adversely impact California business competitiveness, creation, elimination or expansion of jobs and businesses in California. Also, there would be no additional net costs accrued by local and state agencies as a result of the proposed regulation.

***Air Quality Impacts***

By enforcing emission requirements adopted for 2007 and newer HDDEs, the proposed regulation would ensure that the original emission benefits claimed through the adoption of lower emission standards are obtained. The proposed regulation would achieve benefits in two ways. First, the heavy-duty diesel vehicles would be tested in the field, and violations of the emission requirements within the regulatory useful life would be detected and remedied. The proposed program can potentially cover all engine models within a four year period (up to 25 percent tested per year).

The second mechanism is by encouraging the design of robust and durable engine and emission control systems in order to avoid failure of in-use compliance testing and to

prevent potentially costly recalls or extended parts warranties. The effectiveness of in-use compliance programs in encouraging durable emission control components have been demonstrated in the light-duty vehicle program. The initial years of the light-duty in-use compliance program showed high engine family failure or defect rates. After about ten years of routine compliance testing the failure rate decreased to about ten percent or less of the total engine families tested.

# I. INTRODUCTION

Despite significant improvements in California's air quality over the last forty years, more must be done to improve air quality and protect public health. California is currently in non-attainment with the federal ambient ozone and particulate matter (PM) standards over many areas throughout the state. Reductions in mobile source emissions are essential for the attainment of state and federal ozone and PM standards. Diesel engines used in heavy-duty on-road vehicles and off-road equipment are the largest source of ozone-forming nitrogen oxides (NOx), and PM emissions.

Both NOx and PM contribute to serious health problems including premature mortality, aggravation of respiratory and cardiovascular disease, aggravation of existing asthma, acute respiratory symptoms, chronic bronchitis, and decreased lung function. In addition, in 1998 the Air Resources Board (ARB) identified diesel PM as a toxic air contaminant. Compared to other air toxics, diesel PM emissions are responsible for 70% of the total ambient air toxics risk. To address this concern, in 2000 ARB adopted the "California Diesel Risk Reduction Plan." [1] This plan has an aggressive goal of reducing diesel PM levels by 75% and 85% from the 2000 baseline in 2010 and 2020, respectively. The Diesel Risk Reduction Plan has four basic strategies to accomplish these goals: (a) adoption of stringent standards for new heavy-duty diesel engines (HDDE), (b) use of low sulfur clean diesel fuels, (c) aggressive retrofitting of in-use engines with new engines, and (d) ensuring in-use performance of engines to certified standards.

In addition to the California Diesel Risk Reduction Plan, California's 2003 State and Federal Strategy for the California State Implementation Plan (2003 SIP) also outlines measures to reduce ozone forming emissions, including both NOx and reactive organic gases (ROG). One on-road heavy-duty vehicle measure contained in the 2003 SIP is measure "ON-RD HVY-DUTY-3." This measure consists of several regulatory programs such as PM In-Use Emission Control, Engine Software Upgrade, On-Board Diagnostics, Manufacturers' In-Use Compliance, and Reduced Idling. It commits to achieve between 1.4 and 4.5 tons per day (tpd) of ROG and between 8 and 11 tpd of NOx emission reductions in the South Coast Air Basin in 2010. Staff's proposal will help fulfill the fourth goal in the Diesel Risk Reduction Plan; ensuring in-use performance of HDDEs to certified standards.

The federal Clean Air Act grants California the authority to adopt and enforce rules to control mobile source emissions within California. In doing so, however, ARB is required to adopt State requirements that are as stringent, or more stringent, than the federal requirements. Currently, according to the California Code of Regulations,

[1] California Diesel Risk Reduction Program
http://www.arb.ca.gov/diesel/dieselrrp.htm

title 13, sections 2111-2140, the ARB has the authority to conduct in-use compliance testing of HDDEs to ensure compliance with the applicable emission standards throughout their useful life. The California Clean Air Act (CCAA), as codified in the Health and Safety Code sections 43104, also granted ARB the authority to adopt test procedures. Staff's proposal is within the authority granted under the CCAA.

# II. BACKGROUND

On-road heavy-duty vehicles play an important role in both California's and the national economy. Unfortunately, they have also contributed to a significant portion of California's air pollution problems.

## A. EMISSIONS CONTRIBUTION

The primary pollutants of concern from diesel engines are NOx and PM emissions. The high temperatures experienced during the diesel combustion cycle, along with excess air containing oxygen and nitrogen form NOx emissions. PM emissions can be significant under certain operating conditions, caused by incomplete fuel combustion. Lubrication oil and other additives that engines consume also contribute to PM emissions. Because of the presence of excess air (and thus oxygen), hydrocarbon (HC) and carbon monoxide (CO) emissions are relatively low. Fuel evaporative emissions from diesel engines are also relatively low due to the low evaporation rate of diesel fuel.

It is projected that in 2010, on-road HDDEs will contribute approximately 30 percent, or 582 tpd, of the total statewide mobile source NOx emission inventory[2] (see Figure 1). About 20 percent, or 12 tpd, of the projected 2010 statewide diesel PM inventory will be produced by on-road HDDEs (see Figure 2). Note that NOx and PM control for the majority of new off-road diesel engines will be fully implemented by 2015. Measures to clean up existing off-road equipment are under development and slated for Board Consideration around December 2006.

[2] Emission Inventory Data-Almanac Emission Projection Data (Published in 2005) http://www.arb.ca.gov/ei/emsmain/reportform.htm

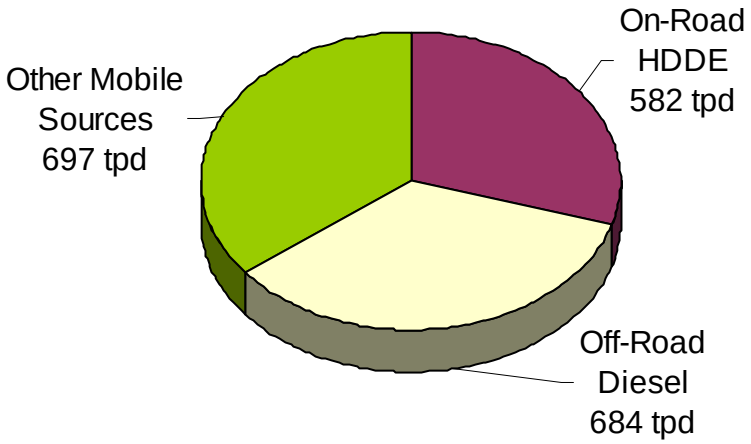



**Figure 1 - 2010 Statewide Mobile Source NOx Emission Inventory ~ 1963 tpd**

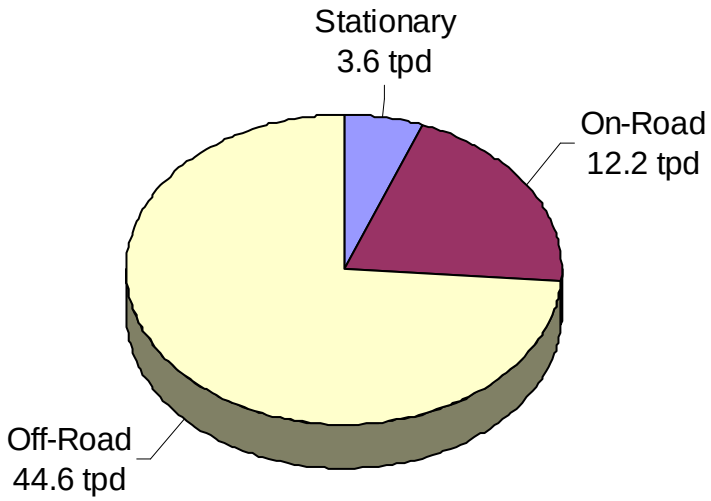



**Figure 2 - 2010 Statewide Diesel PM Emission Inventory ~ 61 tpd**

## B. CERTIFICATION EMISSION STANDARDS

Since 1990, the ARB and the United States Environmental Protection Agency (U.S. EPA) have worked together to harmonize emission control requirements for HDDEs. Consequently, the California and federal emission standards for HDDEs are aligned (see Table 1). In October 1997, U.S. EPA adopted new emission standards for 2004 and subsequent model year HDDEs. The ARB subsequently adopted the same standards in April 1998 that significantly reduced both the HC and NOx emission standards from 1.3 HC and 4.0 NOx to a combined 2.4 non-methane hydrocarbons (NMHC) plus NOx grams per brake horsepower-hour emission standard.

In the mid to late 1990s, with the advent of electronically controlled engines, seven of the largest HDDE manufacturers (herein referred to as the "settling manufacturers") were alleged to have violated state and federal emission laws by designing their engines to turn off emission control devices during sustained highway driving. These cases were resolved through enforcement actions which were concluded when settlement agreements were reached with the settling manufacturers. In these settlement agreements, the settling manufacturers were required, among other things, to produce HDDEs that meet the adopted 2004 2.4 NMHC plus NOx emission standard early, no later than October 1, 2002 (15 months ahead of the regulatory requirements). Also the settling manufacturers agreed to meet supplemental test procedures including Not-To-Exceed (NTE) requirements and the EURO III European Stationary Cycle (ESC) test, starting with 1998 through 2004 model year engines. However, these supplemental test procedure requirements sunsetted with 2004 model year engines. (The NTE and ESC test procedure requirements are discussed in greater detail in section "C." below).

To prevent "backsliding" of the supplemental test procedure requirements after 2004, in December 2000, ARB adopted NTE and ESC supplemental test procedures, applicable to all California certified HDDEs beginning with 2005 model year engines. In addition to preventing backsliding, the adopted regulations also ensure that all other ("non-settling") manufacturers comply beginning with 2005 model year engines.

In January 2001, the U.S. EPA adopted new HDDE emission standards, along with modified NTE and ESC test requirements for 2007 and subsequent model years. These emission standards represent a 90% reduction of NOx, 72% reduction of NMHC, and a 90% reduction of PM emissions compared to the 2004 emission standards. In October 2001, the ARB harmonized with the federal program by adopting identical 2007 HDDE emission standards and NTE and ESC test requirements.

**Table 1 - CA and Federal Heavy-Duty Diesel Engine Certification Emission Standards**

| Model Year | HC (g/bhp-hr) | CO (g/bhp-hr) | NMHC + NOx (g/bhp-hr) | NOx (g/bhp-hr) | PM (g/bhp-hr) |
|---|---|---|---|---|---|
| 1990 | 1.3 | 15.5 | - | 6.0 | 0.60 |
| 1991 | 1.3 | 15.5 | - | 5.0 | 0.25 |
| 1994 | 1.3 | 15.5 | - | 5.0 | 0.10 |
| 1998 | 1.3 | 15.5 | - | 4.0 | 0.10 |
| 2004(1) | - | 15.5 | 2.4(2) | - | 0.10 |
| 2007 | 0.14(3)(4) | 15.5 | - | 0.2(3) | 0.01 |

1 October 1, 2002, for ARB Settlement agreement signers
2 2.5 g/bhp-hr if NMHC is below 0.50 g/bhp-hr
3 Phase in schedule , 50% from 2007 to 2009, 100% in 2010
4 Non methane hydrocarbons (NMHC)

## C. CERTIFICATION TEST PROCEDURES

New motor vehicles and engines are certified by ARB for emission compliance before they are legal for sale, use, or registration in California. Certification is granted annually to individual engine families and is good for one model year. An engine family is a grouping of vehicles or engine models that are similar in design and have similar emission characteristics (e.g., common engine parameters, fuel system, and emission control systems).

For HDDE certification, a representative engine of a specific engine family is tested on an engine dynamometer by the manufacturer under a prescribed test protocol. The testing protocol specifies the test fuel, temperature of the fuel, the different testing cycles to be employed during engine dynamometer testing, and the emissions that are to be measured. The main test cycle that is used for certification is the Federal Test Procedure (FTP). In addition, as previously mentioned, manufacturers must also comply with the NTE and ESC test requirements. The exhaust emissions that are measured during certification testing are NOx, NMHC, CO, and PM.

### 1. Federal Test Procedure

The FTP is a heavy-duty transient cycle currently used for emission testing of on-road heavy-duty engines. This transient test was developed with real world test

data collected on heavy-duty trucks and buses, representing the majority of real world driving conditions, simulating stop and go traffic, idling, and limited freeway driving. The average load factor on the engine is about 20 to 25% of the maximum horsepower available at a given speed. The equivalent average speed of the FTP is about 18.6 miles per hour and the equivalent distance traveled is 6.4 miles with a total run time of 1200 seconds.

### 2. European Stationary Cycle

The ESC is a 13-mode, steady state test procedure, introduced in Europe in 2000 for emission certification testing of HDDEs. Emissions are measured during each mode and averaged over the cycle using a set of weighting factors. PM emissions are sampled on one filter over the 13 modes. This test cycle covers a larger range of engine loads, up to 100% of available engine horsepower. In addition, manufacturers are required to test at three additional test points (or 'mystery points') to ensure compliance under a full range of steady state operating conditions.

### 3. Not-To-Exceed Testing

The NTE requirements were designed to help ensure that HDDE emissions are properly controlled over a large range of speed and load combinations and typical environmental conditions commonly experienced during everyday use of the vehicle. The NTE protocol allows testing on an engine dynamometer, chassis dynamometer, or with on-board portable emission measurement systems (PEMS) during over-the-road operation. The maximum allowable NTE emissions, when averaged over a minimum time of 30 seconds, must not exceed an emission limit that is a multiple of the FTP standards.

NTE establishes an area (NTE control area)[3] under the engine's torque versus speed curve where emissions must not exceed a specified value for any of the regulated pollutants. It also broadens the applicable ambient conditions in which the emission limits must be met including a temperature range of 55-95 degrees Fahrenheit, an altitude range up to 5,500 feet above sea level, and a humidity range from 50 to 75 grains of water per pound of dry air. The test itself does not involve a prescribed driving cycle of any given length (mileage or time); rather it involves any drive cycle that could occur within the bounds of the NTE control area.

The NTE control area includes three basic boundaries on the engine's torque and speed map (see Figure 3). The first is the upper boundary that represents the engine's maximum torque at a given speed. The lower boundary is 30% of

[3] For details see 40 CFR 86.1370-2007(b)

an engine's maximum torque and power. The third boundary is operation above 15% of the ESC speed range. During certification, the HDDE manufacturer does not need to submit NTE test data but must make a statement in their certification application that the engine complies with the NTE requirements.

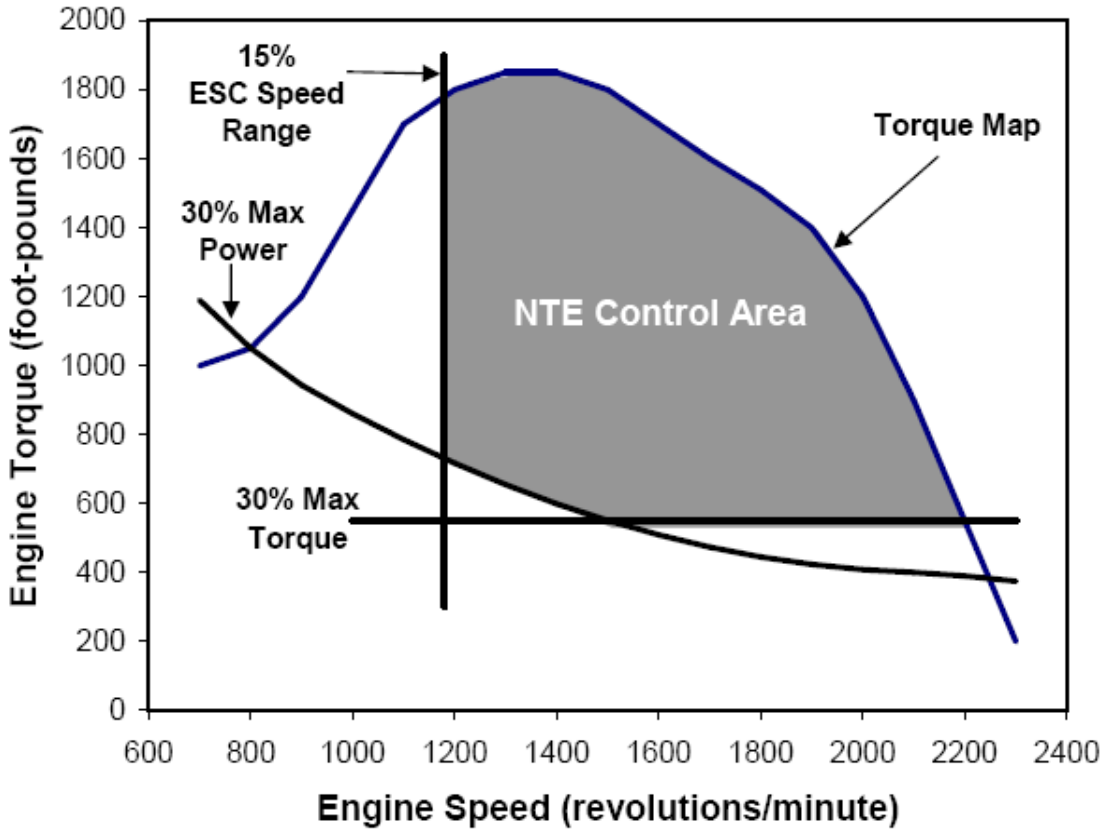



**Figure 3 - Sample NTE Control Area for Heavy-Duty Diesel Engines**

## D. IN-USE COMPLIANCE REGULATIONS

As previously mentioned, California's current authority to conduct compliance testing is found in the California Code of Regulations, title 13, sections 2111-2140. The ARB has the authority to conduct in-use compliance testing of HDDEs to ensure compliance with the applicable emission standards throughout the engine's useful life. According to the current in-use compliance testing procedures, a minimum of ten engines must be tested on an engine dynamometer. To demonstrate compliance, two criteria must be met: 1) the engine family complies with the engine certification emission standards based on

the average emissions of the ten engines tested, and 2) after testing is completed, no more than two defects of the same emission related component can occur.

Despite California's authority to conduct in-use compliance testing on HDDEs, to date no such testing has been performed. This is because it is very time consuming, requiring removal of the engine from the truck (typically requiring one to two weeks per truck/engine). Thus, truck operators are reluctant to volunteer their truck since it is their main source of income, and consequently any downtime would have a significant economic impact. In addition, the testing itself is very costly. Staff estimates that testing an engine family (ten engines minimum) would cost roughly $250,000.[4]

Staff's proposal addresses a long standing need to assess the emissions performance of HDDEs installed in vehicles when operated under a wide range of real-world driving conditions. The proposal is specifically intended to assess compliance with the NTE requirements and to help ensure that HDDEs will comply with all applicable emission standards throughout their useful lives. This proposed program would, for the first time, require engine manufacturers to measure and report in-use exhaust emissions from heavy-duty vehicles using onboard portable emissions measurement systems (PEMS) during typical over-the-road operation. PEMS are miniature versions of analyzers with the same measurement technology used for laboratory testing and can be mounted on the vehicle to conduct field exhaust emissions testing.

## E. COMPARABLE FEDERAL REGULATIONS

Staff's proposal is based on a cooperative effort that began in 2001, with the U.S. EPA and engine manufacturers. Based on this collaborative work, in June 2005, the U.S. EPA adopted a manufacturer-run in-use testing program, titled 'In-Use Testing Program for Heavy-Duty Diesel Engines and Vehicles'. Staff's proposed program is essentially identical to the U.S. EPA's program (U.S. EPA, 2005a, pp 34594 – 34626).

In July 2005, U.S. EPA also modified and consolidated the test procedures for testing both on-road, and off-road diesel engines in 40 CFR, part 1065 (U.S. EPA, 2005b, pp 40420 – 40468). Staff's proposed program will also include those modifications to the 'California Exhaust Emission Standards and Test Procedures for 2004 and Subsequent Model Heavy-Duty Diesel Engines and Vehicles' (see Appendix B).

[4] Federal Register, June 14, 2005, page 34616 (40 CFR Parts 9 and 86, Part III), 'each engine test could cost $25,000 if the vehicle could be procured from an in-use fleet.'

# III. SUMMARY OF PROPOSAL

## A. APPLICABILITY

The proposed program would apply to all 2007 and subsequent model year engine dynamometer certified diesel engines to be installed in vehicles with gross vehicle weight ratings greater than 8,500 pounds. A non-enforceable 2-year pilot program began in 2005 to assess data collection issues associated with gaseous emissions and a 2-year pilot program for PM will begin in late 2006 to assess data collection issues associated with PM emissions.

## B. PROGRAM OVERVIEW

The key elements of proposed program are as follows:

- Each year, ARB and U.S. EPA would designate for testing up to 25% of a manufacturer's total number of medium- and heavy-duty diesel engine families, combined. Testing would be conducted under real-world driving conditions, within the engine's useful life period.
- The engine manufacturers would screen, procure, and test vehicles received either from fleets or individual customers. For details see the vehicle screening guidance document (U.S. EPA, 2006a).
- The proposed program would have two phases. The first phase of testing, Phase 1, is intended to evaluate a designated engine family for conformity with the applicable NTE requirements. If the engine family does not pass the Phase 1 requirements, then Phase 2 testing may be required. Phase 2 testing may be conducted under more defined and narrow test conditions to target specific non-complying operating conditions.
- Emissions that would be measured for compliance are: NOx, NMHC, CO, and PM. Measuring carbon dioxide and oxygen would also be required as a means of verifying fuel consumption and work output (i.e., torque) of the engine.
- Measurement "accuracy" margins would be established to account for the emissions measurement variability associated with the use of PEMS during over-the-road testing, compared to certification testing performed in a laboratory environment (ARB, U.S. EPA, EMA, 2005a).

- During the pilot program years, 2005 through 2007, manufacturers would use interim additive accuracy margins of 0.17 g/bhp-hr for NMHC; 0.50 g/bhp-hr for NOx; 0.60 g/bhp-hr for CO, and 0.10 g/bhp-hr for PM.

- Accuracy margins for the enforceable program are currently being developed through a joint ARB, U.S. EPA, and engine manufacturer sponsored research program.

- ARB personnel may be present during PEMS installation and over-the-road testing.

- Manufacturers are to report test data and other relevant in-use test information to ARB on a quarterly basis, for all engines tested during that quarter, no later than 30 days after the quarter ends.

- Both test data and test reports would be comprehensive in nature and would be submitted in an electronic format jointly developed by ARB, U.S. EPA, and the engine manufacturers.

## C. ENGINE FAMILY AND VEHICLE SELECTION

The ARB estimates that there are about 75 medium- and heavy-duty diesel engine families certified each year by about 13 manufacturers. Because it would be overly burdensome for most manufacturers to test all of their engine families in a single year, the proposal would spread this testing burden out over a four-year period. To accomplish this, most manufacturers would need to test one to two engine families per year. Some manufacturers would need to test up to four engine families per year. Each year, by June 1st, ARB, and U.S. EPA would designate up to 25% of a manufacturer's total number of HDDEs for testing. For the purpose of calculating the number of engine families to be tested in a given year, only engine families with nationwide sales over 1500 engines annually would be used, with a minimum of one engine family per year per manufacturer. However, engine manufacturers would not be required to test over the course of any four-year period, a number of engine families that exceeds the manufacturer's total number of engine families certified unless there is clear evidence of nonconformity with respect to a specific engine family that was tested.

Test vehicles would be obtained from at least two sources and the vehicles would be screened for proper use and maintenance. The vehicles selected for testing would be representative of how the engines are typically used in-use, and there would have to be assurance that they would operate for at least three hours in non-idle operation over a complete shift-day.

Test vehicle engines would be calibrated and set to the manufacturer's original settings, and the manufacturer would verify that the test vehicles have only been operated on commercially available ultra low sulfur diesel fuel or a fuel approved for use by the manufacturer. Manufacturers would verify, remedy, or reject from the program vehicles with an illuminated malfunction indicator light or stored on-board diagnostic trouble code. Manufacturers would not be allowed to screen-out test vehicles for high mileage except for those vehicles that exceed their regulatory useful life.

## D. COMPLIANCE MARGINS

As previously mentioned, using PEMS to assess in-use compliance of HDDEs has many advantages compared to traditional engine dynamometer testing. However, the use of PEMS under various environmental conditions could impact the accuracy of the test results. In order to account for this additional variability, the proposal would allow for the use of an accuracy margin that would be included in the calculations for each pollutant to determine compliance. Measurement accuracy margin development is discussed further in section V, Portable Emission Measurement Systems.

In addition to the measurement accuracy margin, another in-use compliance margin, adopted as per the 2007 HDDE rule, would be applied. It is based on mileage of the engine and is only applicable to NOx and PM emissions for 2007 through 2011 model year HDDEs. For NOx, this compliance margin varies from 0.10 to 0.20 g/bhp-hr, depending on vehicle/engine mileage. The NOx in-use compliance margin is applicable for engines certified to a family engine limit no higher than 1.3 g/bhp-hr. For PM, the in-use compliance margin is 0.01 g/bhp-hr regardless of the mileage. See 40 CFR 86.007-11(h) for more details.

As previously mentioned, the ARB, U.S. EPA, and the engine manufacturers are currently engaged in developing measurement accuracy margins for gaseous emissions which will be used for the enforceable program beginning in 2007. Another test program will be developed to determine a measurement accuracy margin for PM, using it for the enforceable program for PM, beginning in 2008.

## E. VEHICLE PASS CRITERIA

Under staff's proposed program vehicle pass criteria would be used to determine whether an engine meets the NTE requirements it was certified to. In order for an engine to meet the vehicle pass criteria, 90 percent of each NTE sampling event must be below an "NTE threshold." The NTE threshold is comprised of adding the NTE limit, the in-use compliance margin, and the measurement accuracy margin. In addition, for model years 2007 through 2009, each

sampling event must not be greater than two times the NTE threshold, regardless of whether the 90 percent pass criteria are met.[5]

A valid NTE sampling event consists of 30 or more seconds of continuous operation in the NTE control area. Some NTE sampling events may be excluded or limited depending on whether the engine manufacturer, during the time of certification, requested exemptions under certain operating conditions, or was able to show that the engine rarely operates under a certain speed and load.

The average emission level for each pollutant over each valid NTE sampling event would be calculated.[6] Each NTE event would be time weighted, based on the shortest and longest NTE sample collected. The time weighting would be limited to ten times the shortest sample event time or 600 seconds, whichever is less.

After each NTE event has been time weighted, these data will be used to determine whether the vehicle meets the 90 percent requirement under the vehicle pass criteria. To do this, all time weighted NTE sampling events that are below the NTE threshold will be compared with all the NTE sampling events, including events that were above the NTE threshold. If 90 percent or more of the time weighted samples are below the threshold and none of the events were above two times the NTE threshold, then the vehicle would have met the vehicle pass criteria. A comparison would be done for each pollutant and the vehicle must comply with each one to receive a vehicle pass determination.

Table 2 below is an example of how NTE sampling event durations would be evaluated for each pollutant. In the example, six valid NTE samples are collected of different durations, ranging from 40 seconds (sample 1) to 630 seconds (sample 3). Since the smallest sample was 40 seconds, the maximum allowed time weighting is ten times that amount, or 400 seconds. Each sample is then evaluated to determine whether the time interval for each sample needs to be adjusted.

[5] Some exceptions apply. See CFR §86.1912
[6] For details see CFR parts 1065, subpart G

**Table 2 - Illustration of NTE Sampling Events for Calculation**

| NTE sample | Duration of NTE sample (seconds) | Duration Limit Applied? | Duration used in Calculations (seconds) | Below NTE threshold |
|---|---|---|---|---|
| 1 | 40 | No | 40 | No |
| 2 | 165 | No | 165 | Yes |
| 3 | 630 | Yes. Use ten times shortest valid NTE. | 400 | Yes |
| 4 | 470 | Yes. Use ten times shortest valid NTE. | 400 | Yes |
| 5 | 78 | No | 78 | No |
| 6 | 237 | No | 237 | Yes |
| | | | Total NTE time = 1320 seconds | |

Table 2 above is an example of how NTE sampling event durations would be evaluated for each pollutant. In the example, six valid NTE samples are collected of different durations, ranging from 40 seconds (sample 1) to 630 seconds (sample 3). Since the smallest sample was 40 seconds, the maximum allowed time weighting is ten times that amount, or 400 seconds. Each sample is then evaluated to determine whether the time interval for each sample needs to be adjusted.

Once the weighting has been done, the average emission result for each NTE sampling event for each pollutant can be compared with the NTE threshold value for that pollutant to determine whether the NTE sampling event is in compliance. The results of all the sampling events are then compared to determine whether the vehicle met the vehicle pass criteria. In the example above, the vehicle spent a total of 1320 seconds in six different NTE events. The total time the vehicle spent in NTE events that were below the NTE threshold is 1320-(40+78) = 1202 seconds. The ratio of time of complying NTE events to the total NTE events is 1202/1320 = 0.91 or 91%. Thus, the vehicle passes the vehicle pass criteria (assuming that the NTE sampling events 1 and 5 are below two times the NTE threshold value).

## F. 2005 AND 2006 PILOT PROGRAM

The proposed program is unique, in that it would be the first of its kind to require compliance with emission requirements outside of a test laboratory environment using PEMS. Indeed, because it is unique, the ARB, U.S. EPA, and engine

manufacturers have already agreed to launch a pilot program in calendar years 2005 and 2006 to gain experience with in-use testing utilizing PEMS. The pilot program will measure gaseous emissions (i.e., NMHC, CO, and NOx) and will prepare both the manufacturers and ARB for the fully enforceable program, beginning in calendar year 2007. Similarly, a pilot program measuring PM will take place in 2006 and 2007, preceding a fully enforceable program for PM beginning in 2008.

Under the pilot program, engines meeting the 2004 HDDE standards and NTE requirements will be selected for testing. Manufacturers will conduct in-use testing under the Phase 1 test criteria (discussed below in section G.) and will test up to ten vehicles per designated engine family.

The pilot program test data will be used to help refine the program and address testing and reporting issues before the enforceable program begins. There will not be any follow-up remedial actions based solely on the test results of pilot program. However, ARB may utilize pilot program test results, in conjunction with its own test data and other information, to assess or pursue any appropriate remedial or enforcement action.

## G. PHASE 1 TESTING

Figure 4, below, is a flow chart illustrating the compliance determination process for Phase 1 and Phase 2 of the program.

Under Phase 1 testing, test vehicles are to be operated over normal driving routes, carrying their routine loads during typical environmental conditions. The driver normally assigned to the vehicle would be used. The intent of this phase of the program is to assess the emissions from heavy-duty vehicles as they are used and operated on a normal day-to-day basis. Manufacturers would be required to test a minimum of five and a maximum of ten different vehicles within a designated engine family. If five out of five or five out of six vehicles meet the vehicle pass criteria the manufacturer would then be allowed to terminate Phase 1 testing. The manufacturer would not be required to take any further action or submit any further data to ARB for that engine family during that year's testing.

If two out of six vehicles in Phase 1 testing do not meet the vehicle pass criteria, four additional vehicles of the same engine family will be procured and tested. If these additional four vehicles meet the vehicle pass criteria, resulting in eight out of ten vehicles passing, the manufacturer would then be allowed to terminate Phase 1 testing, with no further action required.

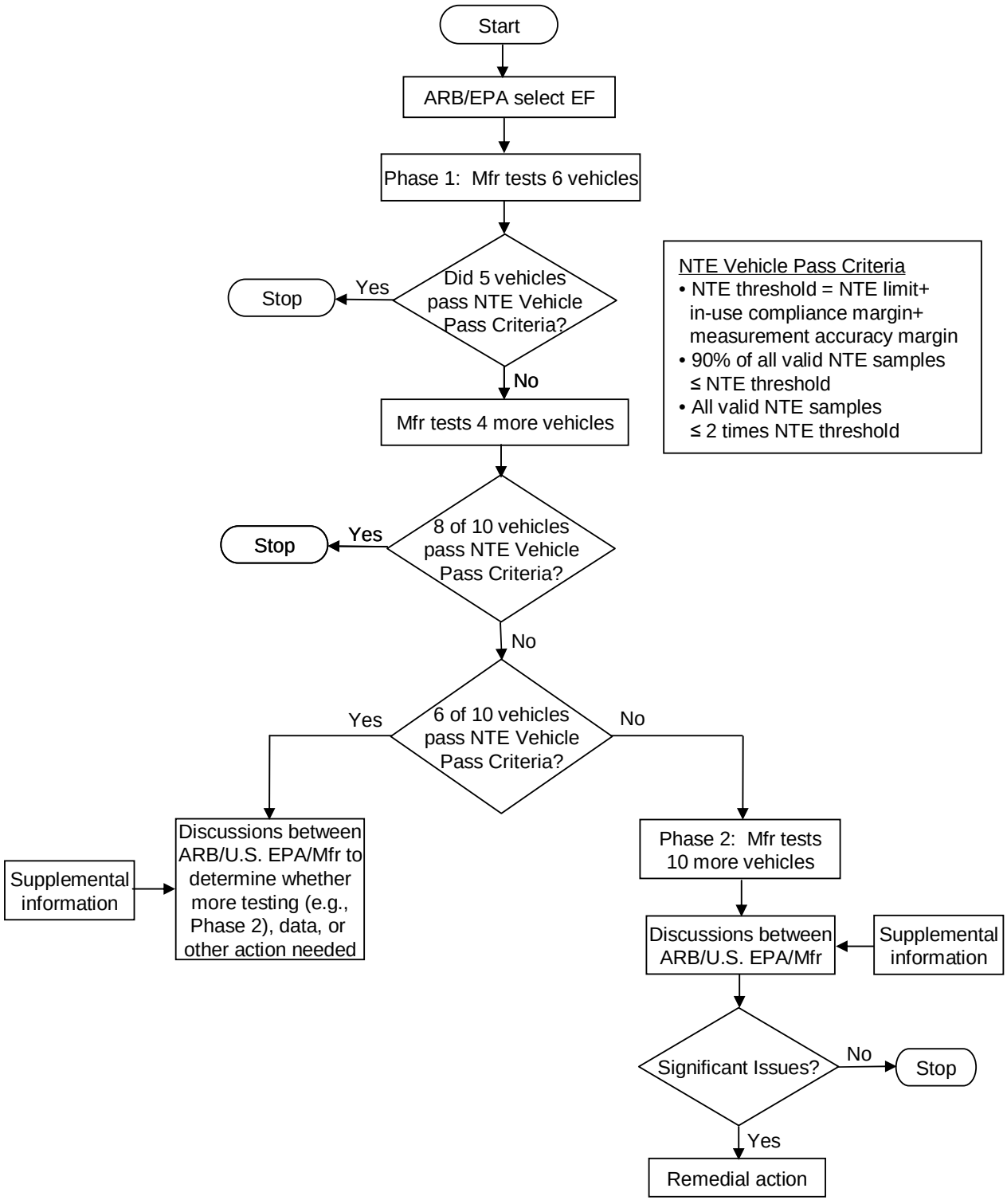



**Figure 4 - Flow Chart of HDDE In-Use Testing Compliance Determination**

If less than eight out of ten vehicles pass, one of two potential follow-up options would be undertaken:

1. If three or four vehicles fail the vehicle pass criteria, the manufacturer would then engage in follow-up discussions with ARB to determine whether any further testing, data submissions or other actions may be warranted. Other actions may include seeking some form of remedial action from the manufacturer.

2. If five or more vehicles fail the vehicle pass criteria, the manufacturer would be required to conduct some form of additional testing, investigation, or other action. The ARB would have the discretion to require the manufacturer to undertake Phase 2 testing unless the manufacturer agrees with ARB that some form of remedial action is warranted.

## H. PHASE 2 TESTING

The primary purpose of Phase 2 testing is to gain further information regarding the extent to which, and under what conditions, the vehicles from the designated engine family failed to pass the vehicle pass criteria during Phase 1 testing (see Figure 4, above). If the manufacturer is required to conduct Phase 2 testing, ten additional vehicles would be selected of the same engine family tested during Phase 1. The ten test vehicles would go through the same vehicle screening protocol used for Phase 1 testing. ARB could require a subclass of engines within the engine family, if the data generated under Phase 1 or other test data indicate possible non-compliance with the emission standards. Additionally, ARB could also specify certain driving routes or other driving conditions (e.g., temperatures, altitudes, geographic locations, or time of year), if it is suspected that these conditions are associated with non-compliance. At any point during Phase 2 testing, ARB and the manufacturer could agree to stop testing and settle on some form of remedial action prior to the completion of testing the additional ten vehicles.

In determining whether to pursue some form of remedial action following Phase 1 or Phase 2 testing, ARB would consider several factors including additional test data submitted by the manufacturer. Such data may be based on tests conducted using PEMS, engine dynamometers, or chassis dynamometers. Other factors staff would consider include, among other things: the margin by which any exceedance(s) were above the NTE threshold; the number of engines that showed an exceedance; the frequency and duration of any exceedance as compared with the aggregate amount of time that all of the test vehicles were operated within the NTE control area; the emissions of the test vehicles over the entire test route, including average(s); the projected emissions impact of the

exceedance and; the relationship of the exceedance at issue to the engine family's ability to comply with the applicable emission requirements.

## I. REPORTING REQUIREMENTS

Under the proposed manufacturer-run compliance program, engine manufacturers would be required to submit test data, and other relevant in-use test information to ARB for each vehicle tested. Manufacturers would be required to submit these data and information on a quarterly basis, no later than 30 days after the quarter ends.

The engine manufacturers' reports would be submitted using a standardized, electronic reporting format. The report would include all measured emissions test data, engine operating parameters, test conditions, test equipment specifications, vehicle and engine information generated during the manufacturer test program (e.g., information on vehicle maintenance and usage history with reasons for rejected vehicles, restorative maintenance performed prior to testing), vehicle pass results, etc. The engine operating parameters that would be reported are engine speed, engine torque or brake specific fuel consumption, engine coolant temperature, intake manifold temperature, intake manifold pressure, and any parameter sensed or controlled that modulates engine operation and emissions. For further details on the manufacturers' reports see the reporting guidance document (U.S. EPA, 2006b).

## J. DETERIORATION FACTOR GENERATION

Currently, manufacturers of HDDEs have considerable flexibility in the generation of deterioration factors (DFs) in the laboratory using an engine dynamometer. The engine is run over a durability driving cycle for a period of time or simulated mileage and emissions are measured over this cycle at intervals specified by the engine manufacturer. The measured emissions are plotted as a function of time or simulated mileage and a statistical curve fitting method is used to calculate emissions deterioration over time. Since the emission tests are not typically performed at the end of an engine's useful life, the curve-fit is extrapolated out to estimate useful life emissions. Once a useful life DF has been determined, the test results and the DF are used in comparison to the standards to determine compliance at time of certification.

During the development of the proposed program, engine manufacturers have requested that they be allowed to use the in-use test data to generate their DFs. Since the manufacturers would be conducting these tests every year and cover most of the engine families they certify within four years, staff concurs that this "real world" methodology to calculate DFs may be a better approach compared

to engine dynamometer laboratory testing. ARB intends to assess the generation of DFs based on the proposed 2005 and 2006 pilot program and may approve the use of in-use data to develop DFs in the future.

## K. ARB'S CONFIRMATORY TESTING

Under staff's proposed program, manufacturers would be procuring, screening, and testing engines that they have previously certified. One of the greatest benefits of this proposed program is the number of engine families that would be tested for compliance, compared to the number of compliance tests that have been conducted in the past. However, because there would be a vested interest for the manufacturers to successfully complete and pass testing of their engine families with a minimum number of engines tested, the ARB would likely perform its own confirmatory testing on selected engine families using the same testing protocol contained in the proposal. This testing would not be meant to duplicate the manufacturers' testing but instead help assure that the manufacturers will select, screen, and conduct the testing appropriately.

## L. OTHER PROPOSED CHANGES

In addition to the proposed in-use compliance program, staff proposes five minor non-substantive modifications. The first proposed amendment corrects the 2007 and later model year NOx emission standard applicable to medium- and heavy-duty diesel engines, and urban buses. When the NOx standard was adopted by the Board in the original rulemaking in 2001, it was staff's intent to propose a 2007 and later model year NOx emission standard that was identical to the applicable federal standard, which is 0.20 g/bhp-hr. When the regulations and the incorporated test procedures were amended, the second decimal place of the NOx emission standard was inadvertently omitted (i.e., it should read 0.20 g/bhp-hr, not 0.2 g/bhp-hr).

The second proposed amendment allows manufacturers to optionally certify medium-duty diesel vehicles under 14,000 pounds gross vehicle weight rating to count towards the phase-in calculations for the 2007 HDDE standards. This allowance was unintentionally overlooked when the 2007 HDDE standards were adopted. This proposed correction would align California's program with the federal program.

The third proposed amendment corrects the formaldehyde standards and the 2007 and later model year Ultra-Low Emission Vehicle standards for medium-duty diesel engines in the "California Exhaust Emission Standards and Test Procedures for 2004 and Subsequent Model Heavy-Duty Diesel Engines and Vehicles." These standards were incorrectly transcribed when the format of the

“California Exhaust Emission Standards and Test Procedures for 2004 and Subsequent Model Heavy-Duty Diesel Engines and Vehicles” was reorganized and updated in December 12, 2002. The corrected amendment makes these emission standards consistent with those in the existing California Code of Regulations.

The fourth proposed amendment aligns the emission DF methodology for HDDEs with the approach currently used by ARB and U.S. EPA for off-road diesel engines. To determine if the emission levels from the emission data engine comply with the applicable emission standards at useful life, DFs, either additive or multiplicative, are applied to the measured emission levels for each pollutant. The proposed amendment harmonizes the approach to determine whether an additive or multiplicative DF is appropriate for on- and off-road diesel engines.

The last proposed amendment updates the labeling requirements for heavy-duty otto-cycle engines. On December 8, 2005, U.S. EPA finalized technical amendments related to streamline evaporative emission testing, in which one of the technical amendments allowed for alternative labeling requirements for 2007 and later model year engines, with advance Administrator approval. Staff also proposes the same alternative labeling allowance for these model year engines.

# IV. DIFFERENCES AND SIMILARITIES BETWEEN CALIFORNIA AND FEDERAL REGULATIONS

Staff's proposed manufacturer-run compliance program is intended to be identical to the program adopted by the U.S. EPA in June 2005. This program would ensure emission compliance from a group of vehicles that affect California's clean air attainment goals and would harmonize both California and federal requirements. For example, engine family and vehicle selection, in-use testing protocol using PEMS, test data and results reporting, and vehicle pass determination are all identical to those adopted by the U.S. EPA in their rule. Only the following element of staff's proposal differ slightly with the federal program.

One of the elements of staff's proposal that may differ with the federal program is how ARB would evaluate the test data for determining compliance. Both U.S. EPA and ARB would coordinate engine family selection and receive the same test data and test results submitted by manufacturers after testing is completed. ARB would make its own interpretation and determination of test results based on the data submitted by manufacturers or in conjunction with other data generated by ARB from its own in-use testing. Thus, ARB's interpretation of manufacturer test results and pursuit of remedial action may be different from actions taken by the U.S. EPA.

# V. PORTABLE EMISSION MEASUREMENT SYSTEMS

The proposal would require engine manufacturers to use PEMS to conduct in-use testing of heavy-duty diesel vehicles. The emission standards for 2007 HDDEs are expressed as mass of pollutant per unit amount of work per unit time. Therefore, at a minimum, the PEMS must be capable of measuring (a) exhaust concentrations of NOx, CO, NMHC, and PM, (b) exhaust flow rate, (c) engine operating speed, torque, coolant temperature, intake manifold temperature, pressure, and (d) ambient conditions such as temperature, dew point, altitude. The success of the program will depend on the availability and reliability of PEMS.

## A. COMMERCIAL AVAILABILITY

The use of PEMS for over-the-road emissions measurement has been under development for the past decade. Testing conducted in the past few years has shown that PEMS technologies have performed well and accurately in measuring gaseous emissions from heavy-duty diesel vehicles under different driving conditions. PEMS emission analyzers used for measuring gaseous pollutants use the same technology used in larger laboratory instruments. On the other hand, the development of the PEMS for PM measurement has been challenging and slower; the technology used for measuring PM with PEMS is completely different than the technology used in a laboratory.

### 1. Gaseous Emissions

Engine manufacturers are likely to certify most of their 2007 through 2010 model year engines at around a 1.1 to 1.3 g/bhp-hr NOx emission level. The corresponding NTE emission limit would be about 2.0 g/bhp-hr, depending upon vehicle mileage and other NTE flexibilities found in the 2007 HDDE rule. Since 2002, there are several commercially available PEMS capable of measuring NOx, CO, $CO_2$, and NMHC at the exhaust concentration levels associated with 2007 and later model year NTE limits. Most analyzers used in PEMS for gaseous measurement are essentially miniature versions of the same instrument used by laboratories. The measurement technology used in PEMs include: a Chemiluminescence detector, zirconia oxide sensor, or non-dispersive ultraviolet (NDUV) detector for NOx; non-dispersive infrared detector for CO and $CO_2$; and a dual flame ionization detector to calculate NMHC. Some of the engine manufacturers are already using PEMS with these technologies to assess emissions compliance with their prototype 2007 model year engines.

### 2. Particulate Matter Emissions

PM measurement has been traditionally conducted by sampling diluted engine exhaust on a filter and then weighing the filter before and after testing to determine the net mass gain due to PM emissions over a test cycle. The same measurement technology can not be applied while testing heavy-duty diesel vehicles over-the-road when using PEMS because real time, second-by-second measurement capability is necessary to satisfy the requirements of the proposed program. Recently, real time PM measurement technologies have been developed and successfully tested in the laboratory. These technologies detect the inertia of collected PM and determine its mass based on the frequency of the vibrating mass rather than collecting PM on a filter and weighing its mass. Technologies using the inertial weight of PM include the tapered element oscillating microbalance and the quartz-crystal microbalance. Recent studies have verified the capabilities of the quartz-crystal microbalance, showing reasonably good measurement accuracy compared to the traditional filter weight based method.

PEMS capable of measuring PM with the above technologies are commercially available today. However, further development work is needed to resolve a few key challenges, such as (a) quantifying semi-volatile hydrocarbons and dilute sulfuric acid PM for every NTE event, (b) matching partial flow dilution of the raw sample in PEMS to match conditions with a typical laboratory's constant volume dilution system, and (c) measuring "nano-gram" levels of PM in 30-second NTE samples.

## B. ACCURACY MARGIN DETERMINATION

There are fundamental differences when exhaust emission measurements are made with stationary analyzers in a controlled laboratory environment compared to emission measurements done with portable emission analyzers in an uncontrolled open environment, subjected to road vibration and other electro-magnetic, and radio-frequency interferences. To account for these factors, in May 2005, ARB, U.S. EPA, and the engine manufacturers agreed to jointly fund and develop a data-driven, research, development, and demonstration project to determine emission measurement "accuracy margins" for gaseous and PM emissions (Memorandum of Agreement, Program to Develop Emission Measurement Accuracy Margins for Heavy-Duty In-Use Testing, May 2005). For a detailed description of the research program, currently underway at the Southwest Research Institute in San Antonio, Texas, see the "test plan" for further details (ARB, U.S. EPA, EMA, 2005b).

# VI. ECONOMIC IMPACTS

## A. LEGAL REQUIREMENTS

Government Code sections 11346.3 and 11346.5(a) require state agencies adopting and amending any administrative regulations to identify and assess the potential for adverse economic impacts on California businesses and individuals. State agencies are also required to estimate the cost or savings to any state or local agency and school districts. The assessment shall include a consideration of the impact of the proposed regulation on California jobs, business expansion, elimination or creation, and the ability of California business to compete with business in other states.

State agencies are also required to estimate the cost or savings to any State or local agency and school district in accordance with instructions adopted by the Department of Finance. The estimate shall include any non-discretionary cost or saving to the local agencies and the cost or saving in federal funding to the State.

## B. AFFECTED BUSINESSES

The proposed regulation will affect businesses that manufacturer on-road HDDEs and PEMS units. Based on 2005 California certification data, 13 heavy-duty engine manufacturers certified their engines for sale in California. None of these manufacturers is located in California, and none is considered to be a small business. The total number of affected PEMS manufacturers is difficult to determine at this time because some manufacturers are still developing their products. Currently, at least four manufacturers have offered for sale PEMS that measure gaseous emissions. One of these manufacturers is located in California and is a small business.

## C. POTENTIAL COSTS TO ENGINE MANUFACTURERS

From one perspective, the proposed regulation poses no additional costs to engine manufacturers who certify in California since the manufacturers are already subject to an identical nationwide rule adopted by U.S. EPA on June 14, 2005 (i.e., no additional testing beyond what is required by the federal rule). Nevertheless, the proposed regulation can be viewed as imposing new testing costs on manufacturers when compared to current California law which does not impose any in-use testing cost on them. These new in-use testing costs would be identical to the estimated nationwide costs since it imposes about the same number of tests and requirements as the nationwide program.

Inasmuch as the proposed amendments could be said to have economic impacts, these impacts are expected to be slight and absorbable by the manufacturers of HDDEs.

The U.S.EPA cost estimate to conduct the manufacturer-run in-use compliance program nationwide ranges from $1.6 to $2.1 million per year for the entire industry (U.S. EPA, 2005c)(Table 3). The total cost consists of fixed and variable cost components. In this program, the fixed costs are the direct expense of purchasing PEMS units. U.S. EPA has estimated that the annualized cost per PEMS unit is $34,145 [7] and that each manufacturer, on average, will purchase 3 units. Assuming 13 affected engine manufacturers, the total annualized fixed cost of the program is $1,331,655. The variable costs are dependent on the number of engine families tested and the numbers of tests performed, and include costs for direct labor, other direct costs, labor overhead, vehicle incentives, travel, and administrative overhead. The variable cost for each engine family is estimated to range from $15,491 to $44,411. Assuming 18 engine families (25 percent of 71 engine families certified federally in the 2005 model year) are tested per year, the total annualized variable cost of the program is estimated to range from $278,838 to $799,398. When combining the fixed and variable costs together, the average cost per manufacturer ranges from $123,884 to $163,927. The actual cost to a specific manufacturer will vary depending on how many engine families it certifies, how many vehicles are tested in Phase 1 for a given engine family, whether Phase 2 testing occurs for a given engine family, and other variables.

**Table 3 - Total Annualized Cost for the Nationwide Program**

| Costs | Minimum | Maximum |
|---|---|---|
| Fixed Annualized Costs | $1,331,655 | $1,331,655 |
| Variable Annualized Costs | $278,838 | $799,398 |
| Total Annualized Costs | $1,610,493 | $2,131,053 |
| **Average Cost Per Manufacturer** | **$123,884** | **$163,927** |

## D. POTENTIAL IMPACTS ON PEMS MANUFACTURERS

The proposed regulation imposes technical specifications on PEMS for use in the proposed program. However, there is no certification process to qualify PEMS for use in the proposed regulations and thus; heavy-duty engine

[7] This annualized PEMS cost assumes the capital cost for a unit that measures both gaseous and PM emissions of $140,000, a product life of five years, and a capital recovery rate of seven percent per annum.

manufacturers will be responsible to ensure that the PEMS used in the proposed program meet the required specifications. Businesses that manufacture PEMS may incur additional cost to further develop their systems to meet the engine manufacturer needs under this program, but that cost can be recovered during the sale of other PEMS and they should not be adversely impacted by the proposed regulations. Rather, the proposed regulations, along with the national rule, should increase the sale of PEMS due to the market demand for this technology under this program. This program, implemented on a nationwide basis, will potentially result in the average annual sale of $1.3 million in PEMS (based on fixed costs noted above). Therefore, the economic impact on the manufacturer of PEMS that is located in California may be slight and positive.

## E. POTENTIAL IMPACTS ON BUSINESS COMPETITIVENESS

The proposed regulation is not expected to adversely impact the ability of California businesses to compete with similar businesses in other states. As noted earlier, the U.S. EPA has already adopted this program on a nationwide basis and thus, businesses in all states will be subjected to identical requirements.

## F. POTENTIAL IMPACTS ON JOBS AND BUSINESS CREATION, ELIMINATION, OR EXPANSION

The proposed regulation is not expected to significantly impact the creation, elimination or expansion of jobs and businesses in California. Any effect on employment, business creation or expansion is expected to be slight but positive. Engine manufacturers may hire additional personnel to perform tasks in the proposed program but this impact will not likely be realized in California since none of the manufacturers are located in California. If an engine manufacturer were to test vehicles in California, there could potentially be an increase in jobs or the creation of businesses to test HDDVs. However, this is also unlikely because the manufacturer is expected to utilize its own staff rather than outsourcing the testing. In addition, although one PEMS manufacturer is located in California and staff's proposal may expand that business, it is unknown whether engine manufacturers will purchase PEMS from this California business and how many units may be purchased.

## G. POTENTIAL COSTS TO LOCAL AND STATE AGENCIES

The proposed amendments to the Procedure will not create costs or savings, as defined in Government Code section 11346.5 (a)(6), to any State agency or in federal funding to the State, costs or mandate to any local agency or school

district whether or not reimbursable by the State pursuant to part 7 (commencing with section 17500, division 4, title 2 of the Government Code), or other non-discretionary savings to local agencies. The staff has not encountered information that indicates that any of these impacts is to be expected.

No additional net costs for local and state agencies will be accrued as a result of the proposed regulation. If an engine manufacturer chooses to procure vehicles for the proposed program through a local or state agency, participation is strictly voluntary, and the agency will be provided an incentive for the use of the vehicles. In addition, the cost for ARB to enforce the proposed program should be absorbed within the existing ARB programs and budget, and thus no additional costs are anticipated.

# VII. ENVIRONMENTAL IMPACTS

## A. AIR QUALITY IMPACTS

By enforcing emission limits adopted for HDDEs, the proposed regulation would ensure that the original emission benefits claimed through the adoption of lower emission standards are obtained. The next phase of HDDE emission standards will require a 90 percent reduction in NOx and PM emissions compared to today's standards, and will start in 2007 and be fully phased-in by 2010. Vehicles certified to these standards will have added complexity compared to today's vehicles due to the use of advanced aftertreatment systems and feedback controls to enhance emission control effectiveness. The proposed enforcement program will ensure that the emission control systems on HDDEs are properly designed and sufficiently durable to comply with the emission requirements during their useful life.

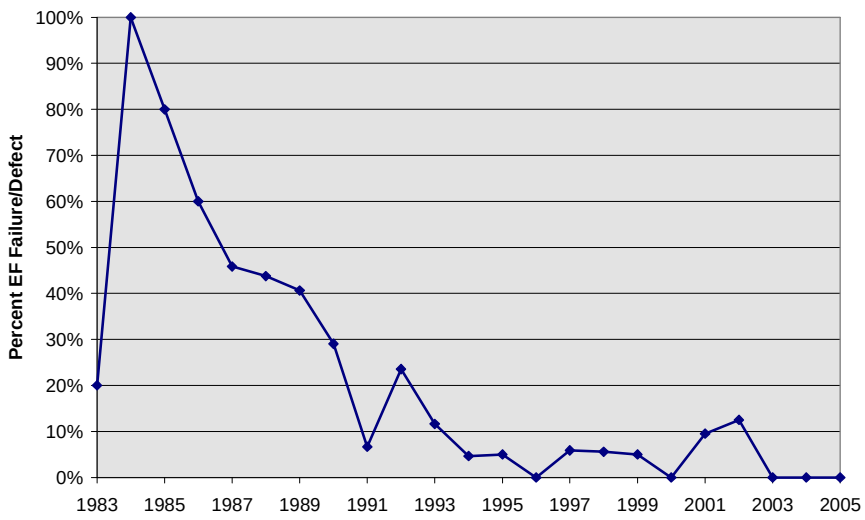
The proposed regulation will achieve benefits by routinely testing heavy-duty diesel vehicles in-use to ensure compliance with emission requirements as well as providing manufacturers an incentive for improved engine designs. With regard to in-use compliance, heavy-duty diesel vehicles will be tested in the field, and violations of the emission requirements within the regulatory useful life will be detected. The proposed program can potentially cover all engine models within a four year period (up to 25 percent tested per year). However, it is unknown how to quantify the actual environmental benefits because the number of vehicles failing the proposed program and their failed emission rate compared to a properly operating vehicle must be first determined in order to calculate the emission benefit. These two factors cannot be estimated at this time.

With regard to an incentive for improving designs, staff's proposal will encourage the design of robust and durable engines and emission control systems in order to avoid failure of in-use compliance testing and to prevent potentially costly recalls or extended parts warranties. It is also uncertain how to quantitatively calculate this emission benefit at this time, but the effectiveness of in-use compliance programs in encouraging durable emission control components have been demonstrated in the light-duty vehicle program. The light-duty vehicle in-use compliance program, which is operated by ARB rather than by manufacturers as in the proposed program, began in 1983. The initial years of the light-duty in-use compliance program showed high engine family failure or defect rates (Figure 5). After about ten years of routine compliance testing the failure rate decreased to about ten percent or less of the total engine families tested. In fact, in the last three years, no engine families have failed light-duty in-use compliance testing. The In-Use Verification Program, another enforcement program for light-duty vehicles that began in 2001, is manufacturer-run, similar to the proposed regulations. Since its initiation, no engine families have failed.

The current low failure rate is evidence of the success of these and other light-duty enforcement programs, most notably the on-board diagnostics program. In addition, in 2001, ARB introduced another light duty vehicle enforcement program, the in-use volunteer program that requires the manufacturers to test their in-use vehicles, similar to the proposed regulation for HDDEs.

As mentioned earlier, the proposed manufacturer-run in-use testing and compliance program is part of Measure ON-RD HVY-DUTY-3 in the 2003 SIP. This measure describes various approaches to clean up the existing and new truck fleet. Since the environmental benefits of the proposed regulation are not quantifiable, no SIP emission benefits will be claimed through the proposed regulation. Note that the SIP emission reduction commitments for Measure ON-RD HVY-DUTY-3 have already been met by other adopted approaches contained in the Measure.

**Figure 5 - Light-Duty Vehicle In-Use Compliance Testing Engine Family Failure/Defects from 1983 to 2005**




## B. ENVIRONMENTAL JUSTICE

State law defines environmental justice as the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies. The Board has established a framework for incorporating environmental justice into ARB's programs consistent with the directives of State law. The proposed regulation would benefit all Californians by ensuring that

HDDEs comply with certification emission standards throughout their useful life. Communities located in proximity to ports, distribution centers, and other areas with high heavy-duty diesel vehicle activity would particularly benefit from the proposed regulation.

# VIII. REGULATORY ALTERNATIVES

Several alternatives to the proposed requirements have been evaluated, as described below. After careful consideration of each alternative, the proposed regulation was determined to be the best option. A description of each alternative and the rationale for rejection are described as follows.

## A. NO ACTION

If ARB did not take any action to adopt the proposed requirements, it will still have the authority to conduct in-use compliance testing under its current in-use compliance regulations. Under these regulations, we would perform engine dynamometer testing. If ARB would test the same annual number of engine families as in the proposed program, staff estimates the annual costs would be $4.5 million. In addition, since U.S. EPA has already adopted this program on a nationwide basis, vehicles in California would be subjected to the federal in-use compliance program. The main disadvantage of not taking any action is that California would not be able to enforce its own regulations through the convenience of a manufacturer-run in-use compliance program. Due to its severe air pollution problem, California is the only state given the authority to adopt its own emission standards, and the ability to enforce the standards is a critical component to the effectiveness of the regulations. While the proposed program is identical to the federal program in practically all aspects, retaining ARB's authority to enforce the HDDE regulations through the proposed manufacturer-run program would allow it to specify engine families to be tested, interpret the generated emission data to determine appropriate next steps, and make key decisions regarding the consequences of engine families failing to meet the requirements of the proposed program. In addition, many of the elements of the proposed rulemaking resolve concerns that engine manufacturers had regarding the NTE test, such as how the NTE emissions would be calculated and what would constitute a failed NTE test. By not taking any action, manufacturer concerns regarding the NTE test would not be addressed.

## B. OPERATE THE PROPOSED IN-USE TESTING AND COMPLIANCE PROGRAM WITHOUT MANUFACTURER INVOLVEMENT

In this alternative, the proposed in-use testing and compliance program would be performed by ARB instead of the manufacturer. In this case, ARB would have full control over the program and would be able to procure vehicles from anywhere within the state and to test vehicles under whatever representative ambient conditions that it deemed necessary. The main disadvantage to this

alternative is the difficulty in procuring vehicles to participate in the program. On-road heavy-duty trucks are mostly used for business purposes, and truck owners are typically not willing to allow government representatives to modify their vehicles to install a PEMS, potentially disrupting their work day. Engine manufacturers, however, have established working relationships with many truck fleet owners and have extensive knowledge of their engines such that any potential disruption to the use of the vehicle is minimal, if any. Also, the engine manufacturer can assure the owner that the engine warranty would not be voided because of any modifications and provide appealing incentives for participation in the program. Although HDDEs can be obtained through government agencies in California, the available selection of the manufacturer and model of the engines is limited. Also, California is not precluded from conducting its own in-use testing if information regarding a possible non-complying engine family is reported. Assuming that ARB can procure and test HDDEs using PEMS at the same cost as the engine manufacturers, the cost that would be incurred to test the same number of families would be $1.8 million per year. Thus, by considering the advantages and disadvantages of this alternative, conducting the proposed in-use testing and compliance program by ARB would result in only limited test capability, whereas manufacturer involvement would provide greater effectiveness in potentially testing the full range of engine families certified.

## C. REQUIRE THE USE OF CHASSIS DYNAMOMETER FOR IN-USE TESTING AND COMPLIANCE

Another alternative to the proposed regulations is to require the use of a chassis dynamometer for testing rather than the use of PEMS and testing would be conducted under ARB's current regulation. ARB owns and operates a heavy-duty chassis dynamometer in Los Angeles. Testing on a chassis dynamometer would require the generation of representative test cycles and correlation of measured emissions to the NTE emission limits. One of the main advantages of a chassis dynamometer is the quality of the emission analyzers, which are certification-grade and thus, correlates well with the equipment used by the engine manufacturers during certification. In addition, repeat tests of a given driving cycle can be performed for a more precise understanding of the emission performance of an engine, as compared to a single and unique test run on an engine using PEMS. The major disadvantage of the use of a chassis dynamometer, compared to PEMS, is its inability to generate emission data during real-world driving and under diverse ambient conditions experienced by a vehicle in the field. Another disadvantage is the need to generate representative driving cycles to test on a chassis dynamometer since the NTE requirement specifies testing under representative driving conditions. In addition, relative to PEMS, chassis testing is more expensive and time-consuming. Assuming that ARB would test the same number of engine families as the proposed program,

staff estimates the annual costs to conduct such a chassis-dynamometer based program would be $3.6 million. Therefore, at this time, the use of PEMS for in-use compliance testing is the preferred option over the use of a chassis dynamometer.

# IX. REMAINING NON-CONTROVERSIAL ISSUES

## A. PEMS SUPPLIER

As indicated in section V, the success of the proposed manufacturer-run in-use compliance program would greatly depend on the commercial availability of PEMS capable of measuring both gaseous and PM emissions from HDDEs. There are several commercial PEMS suppliers that can effectively measure the gaseous emissions during over-the-road testing. However, more development is needed to improve PM measurement capabilities.

## B. ENFORCEABLE PROGRAM IMPLEMENTATION

The proposed program would be enforceable beginning with 2007 model year HDDEs. But this assumes that the measurement accuracy margins have been determined and the two pilot programs for both gaseous and PM are either completed or at least underway to gain necessary experience before the start of the enforceable program. Thus, if major milestones slip, the enforceable program could be delayed. The timeline for the manufacturer-run in-use compliance program is indicated below in Table 4.

**Table 4 - Time Line for Manufacturer-Run In-Use Compliance Program**

| Program Name | ARB/U.S. EPA Engine Family Selection date, by | Manufacturer test completion and reporting date, by |
|---|---|---|
| 2005 Gaseous Pilot | June 2005 | November 2007 |
| 2006 Gaseous Pilot | December 2006 | June 2008 |
| 2006 PM Pilot | December 2006 | June 2008 |
| 2007 PM Pilot | December 2007 | December 2009 |
| 2007 Gaseous Enforceable | December 2007 | December 2009 |
| 2008 Gaseous & PM Enforceable | October 2008 | April 2010 |
| 2009 Gaseous & PM Enforceable | June 2009 | December 2010 |

# X. SUMMARY AND STAFF RECOMMENDATIONS

The proposed manufacturer-run in-use compliance program addresses a long standing need to monitor the emission performance of HDDEs installed in on-highway vehicles when they are operated over a wide range of real-world conditions. It is specifically intended to monitor compliance with NTE requirements and to help ensure that HDDEs will comply with all applicable emission standards throughout their useful lives. The proposed regulation is also necessary to help meet clean air goals as specified in the 2003 SIP. The following specific benefits would be gained with the adoption of staff's proposal

- The use of commercially available PEMS would significantly reduce the testing cost and time of testing HDDEs.

- The proposed requirements would result in a cost savings to the engine manufacturers by aligning California and federal compliance programs, resulting in testing fewer HDDEs than they would otherwise be required to do if two separate compliance programs were in place.

- The proposed testing program would generate a huge amount of HDDE in-use test data that can be used effectively both by the manufacturers and ARB.

- The manufacturers would be able to evaluate the performance of the HDDEs and emission control systems under real world operating conditions and use. The test data could be used to create cleaner and more durable engine designs.

- ARB would be able to use HDDE in-use test data to make an independent evaluation regarding the need for any further testing of an engine family when some of the test data show possible non-conformity. In the future, ARB may also use the HDDE in-use test data to develop in-use emission factors for emissions and air quality modeling.

Staff therefore recommends that the Board adopt the proposed manufacturer-run in-use compliance regulation. The staff also recommends that the Board amend sections 1956.1, 1956.8, title 13, CCR, and the incorporated "California Exhaust Emission Standard and Test Procedures for 2004 and Subsequent Model Heavy-Duty diesel Engines and Otto-Cycle Engines and Vehicles" as set forth in Appendices A, B and C. The proposed regulatory language for California's manufacturer-run in-use compliance program is essentially identical to the requirements adopted by the U.S. EPA.

## XI. REFERENCES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